Chapter 2
Formation of Primordial Bioorganic Molecules

Chemical evolution concerns the chemical processes that occurred on the ancient Earth about 4.5–3.5 million years ago. It is important to note that it preceded biological evolution that resulted in the formation of protocells. These forerunners of today's living cells were capable of self-reproduction at the expense of some protometabolism. After Oparin's ideas of the origin of life became widely known and especially after Stanley Miller reported his prebiotic soup experiments in 1953, the concept of chemical evolution became accepted.

Living matter consists of six indispensable elements, namely C, H, O, N, P, and S, and, in addition, many more trace elements, for instance, iron. These elements are capable of existing in different valence states and are thought to have predominated the ancient Earth.

Different sources of energy were available on the surface and in the upper mantle of the early Earth. The sources of energy include volcanism, sun light, electricity, natural radioactivity, cosmic radiation, and reaction enthalpies.

The main reaction products of prebiotic chemistry were H_2, H_2O, CH_4, CO, CO_2, NH_3, and N_2. These compounds formed many intermediates including ions and radicals. The more important molecules that formed were formaldehyde HCHO, hydrogen cyanide HCN, phosphate ions, and cyan amide NH_2CN. The final spectrum of products encompassed glycerol, glyceraldehyde – the parent compounds of sugars – carboxylic acids, amino acids, urea, guanidine, purines, and pyrimidines. As an example for the many possible interactions the formation of the nucleobase, uracil is shown in Fig. 2.1.

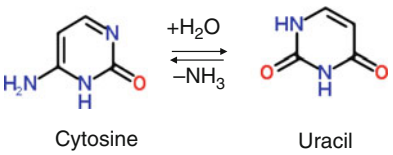

Fig. 2.1 Cytosine reacts with water to form uracil. The reverse reaction occurs when uracil reacts with ammonia

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